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Water Quality Guidance: Development of Residuals Management Strategies An Executive Summary

Indiana Univ.

Prepared For
Environmental Protection Agency

January 1976

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Water Quality Guidance

DEVELOPMENT OF RESIDUALS MANAGEMENT STRATEGIES

AN EXECUTIVE SUMMARY

U.S. Environmental Protection Agency
Washington, D.C. 20460

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The subject of this summary is a study of the development of strategies for managing the residuals that result from human activity. Residuals - "leftovers" that inevitably result from all human activity - are often referred to as wastes or pollutants. The idea of residuals management includes both the concept of waste management and pollution control.

This study contains step by step guidlines for identifying alternate residuals management strategies and then evaluating and selecting a strategy. The selected strategy will provide decision makers with an economical and effective means of solving their problem.

17. Key Words and Document Analysis. 17a. Descriptors

planning, waste disposal, management, management engineering, management methods, environmental planning, regulations, wastes, pollutants,

17b. Identifiers/Open-Ended Terms

residuals, residuals management, waste management, residuals generation and discharge model, strategy selection, implementation, residuals management strategies

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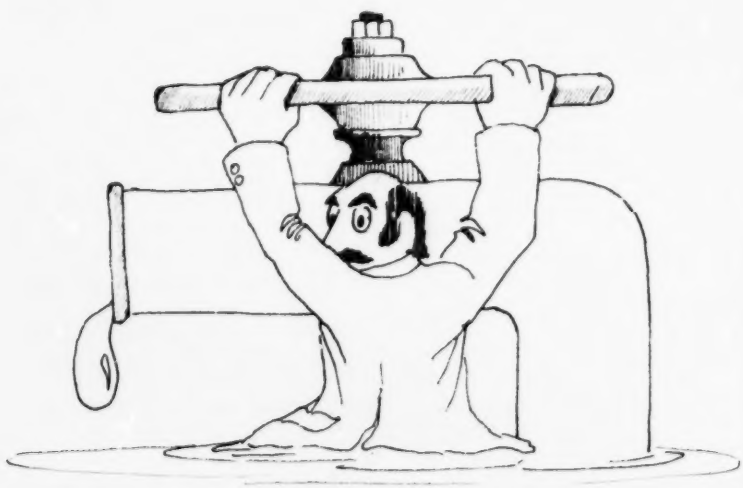
1 Introduction

- THE SUBJECT OF THIS SUMMARY
- THE INTENDED AUDIENCE
- THE PURPOSE OF THE STUDY
- DEFINITIONS



1. INTRODUCTION

THE SUBJECT OF THIS SUMMARY . . .

is a study of the development of strategies for managing the residuals that result from human activity. Conducted by Indiana University's School of Public and Environmental Affairs, for the U.S. Environmental Protection Agency, the study offers an approach to the problem of residuals management.

Residuals—"leftovers" that inevitably result from all human activity—are often referred to as "wastes" or "pollutants." The idea of residuals management includes both the concept of waste management and pollution control.

As any manager or administrator knows, it is often difficult to decide which approach to a residuals problem will work best. This study contains step-by-step guidelines for identifying alternate residuals management strategies and then evaluating and selecting a strategy. The selected strategy will provide decision makers with an economical and effective means of solving their problems.

THE INTENDED AUDIENCE . . .

of this study includes all of the people who make informed decisions about residuals management:

1. Elected officials—mayors and governors, city councils, and state and national legislators;
2. Appointed administrators—commissioners of city departments, directors of state agencies;
3. Public interest groups—special interest groups and groups with general environmental objectives;
4. Planners and analysts for city and state government;
5. Managers of residuals generators, both publicly and privately owned.

THE PURPOSES OF THE STUDY . . . ARE TWOFOLD

Generally, the study is designed

1. To identify and describe a number of means for achieving environmental quality in a fair and cost-effective way;
2. To help decision makers and managers find and implement the best ways for them to manage residuals in order to enhance environmental quality.

Specifically, the study seeks

1. To help administrators develop and maintain flexibility in selecting methods for improving the environment;
2. To protect citizens from inequities and hardships which result from implementing environmental controls without considering a range of possible alternatives;
3. To reduce the costs of environmental quality to the general taxpayer by
   - reducing the need for publicly financed residuals treatment works;
   - reducing operation and maintenance costs of publicly owned and operated facilities;
   - reducing the cost of public supervision and regulation of discharging residuals into the environment; and
   - shifting the cost of environmental protection and improvement to residuals generators and discharges.

DEFINITIONS

- Physical Methods: Technological or structural actions which result in a change of the quantity, type, timing, or spatial location of residuals discharged into the ambient environment and/or improve the assimilative capacity of the natural environment. Examples of physical actions are changes in production process technologies, changes in the operating rate of the production process, treatment of residuals (changing form), in-stream aeration, and so on.
- Implementation Measures: Non-structural actions such as laws, regulations and ordinances to induce implementation of desired physical methods. Implementation measures also achieve established goals and objectives consistent with established policies. Examples of implementation instruments include performance and product specifications, emissions (residuals) limitations, zoning, federal funding for treatment plants, accelerated depreciation for pollution control devices, phosphate limitation on home laundry detergents, and so on.
- Institutional Arrangements: The established public organizations at all levels which establish goals and objectives, which have the authority to identify and adopt implementation measures. Institutional arrangements also include intra-organization and inter-organization arrangements. Examples include federal, state, city, county, regional, and interstate legislative and administrative bodies.
- Residuals Management Strategy: A combination of physical methods, implementation measures, and institutional arrangements adopted for the purpose of reducing or eliminating the discharge of residuals into the environment and/or reducing or eliminating their impact if discharged—i.e. achieving environmental quality objectives.

Physical methods may be viewed as the "hardware" as compared to the other components which may be viewed as the "software" of the residuals management strategy.

2 The Study

- THE PROBLEM
- THE CAUSES
- THE SOLUTION
- THE PROCESS
- THE PROPOSED SYSTEM
- EXAMPLES

2. THE STUDY

WHAT IS THE PROBLEM?

The problem is residuals. In response to demand, goods and services are produced; the production process itself creates some residuals. After the goods and services reach the consumer, they are "consumed"; this use also results in residuals.

WHAT CAUSES THE PROBLEM?

1. We have not considered environmental resources as items to "cost out" when combining the production resources of labor, capital, and raw material to produce goods and services.

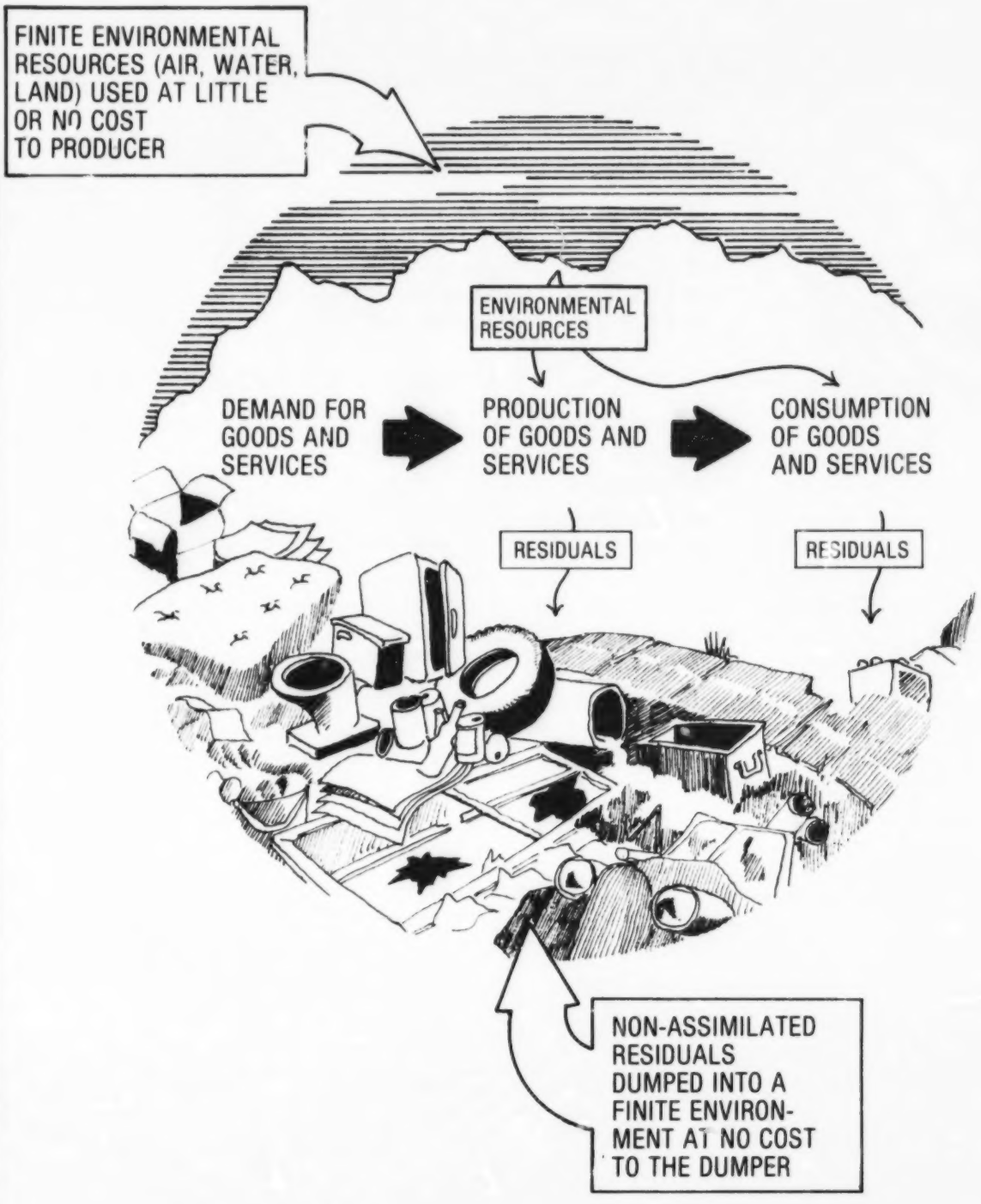
   We have used environmental resources—air, water, land—relatively freely in producing and disposing of goods; that is, we have combined our production resources in such a way as to exploit environmental resources as extensively as possible—because environmental resources have cost little or nothing.

2. We have built up a consume-and-discard way of life. When goods like cars, appliances, clothes, or even buildings no longer provide the kind of utility we think we want, we "throw them away."

3. We have assumed that "away" is in the environment, ignoring a law of Nature: the conservation of mass and energy —the same quantity of material that went into a product remains in existence, even if the product itself does not. A product is not really "consumed," it merely changes form. It usually changes into the form of residuals which are deposited into the environment.

4. Until recently, we considered the environment adequate to the task of assimilating residuals as part of our use of environmental resources. We are now beginning to realize that the environment has only a finite capacity to assimilate some residuals from production and consumption; and we are beginning to see that the quality of human life suffers when the environment is taxed beyond that finite capacity.

THE ENVIRONMENT IS A FINITE SOURCE OF MATERIALS WITH A FINITE CAPACITY TO ASSIMILATE RESIDUALS


FINITE ENVIRONMENTAL RESOURCES (AIR, WATER, LAND) USED AT LITTLE OR NO COST TO PRODUCER
ENVIRONMENTAL RESOURCES
DEMAND FOR GOODS AND SERVICES
PRODUCTION OF GOODS AND SERVICES
CONSUMPTION OF GOODS AND SERVICES
RESIDUALS
RESIDUALS
NON-ASSIMILATED RESIDUALS DUMPED INTO A FINITE ENVIRON-MENT AT NO COST TO THE DUMPER

THE SOLUTION TO THE PROBLEM . . . MANAGING RESIDUALS

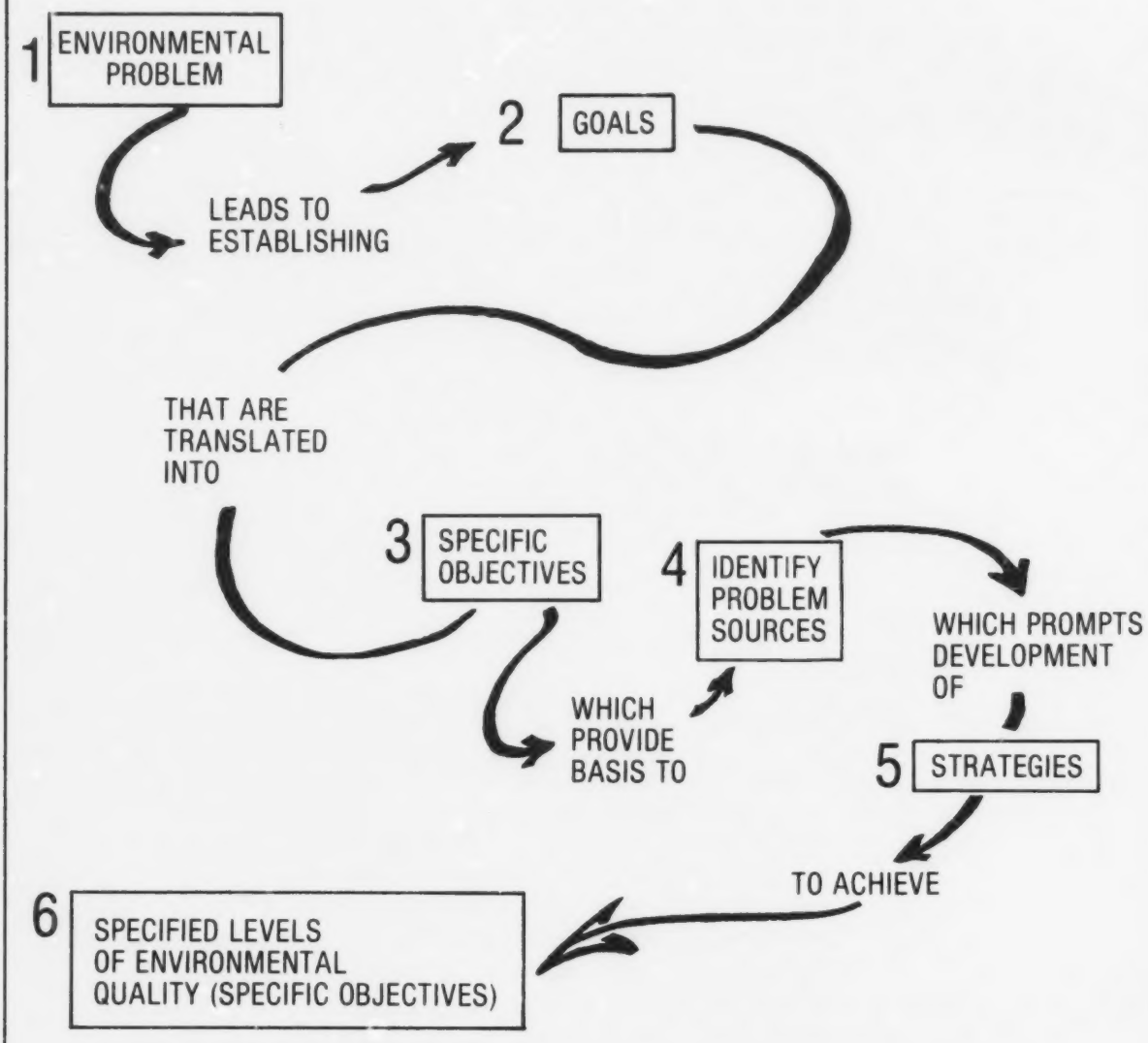
Through their government officials, people make a number of decisions regarding environmental improvement. Such decisions consider

1. Factors Influencing Plans for the Environment
   - level of environmental quality desired
   - costs of achieving that quality
   - who bears those costs
   - benefits of enhancing environmental quality
   - strategies for achieving that quality
2. And Constraints on Environmental Management
   - economic
   - legal
   - political
   - technological
   - social

These basic decisions are used to establish long-range goals for levels of environmental quality to be achieved and interim goals, or objectives, to be reached.

Goals and objectives are set up during the planning process, which also includes identifying and selecting strategies for achieving goals. Planning and strategy selection are essential to effective residuals management.

A SYSTEMATIC PLANNING PROCESS CONSIDERS THE PROBLEM AND THE FACTORS INSTRUMENTAL TO ITS SOLUTION.



Constraints such as political, economic, legal, scientific, technological, and social considerations affect this process, principally in Steps 3, 4, and 5.

THE PROCESS

Through the systematic identification, selection, and evaluation of strategies for residuals management, administrators can determine the most effective ways to attack an environmental quality problem. The process is outlined in the following pages.

THE PROPOSED SYSTEM FOR RESIDUALS MANAGEMENT

1. UNDERSTAND THE RESIDUALS GENERATION AND DISCHARGE PROCESS

Within the framework of an overall environmental quality management system, the proposed system for managing residuals begins with a consideration of the residuals generation and discharge process as depicted in a simple model.

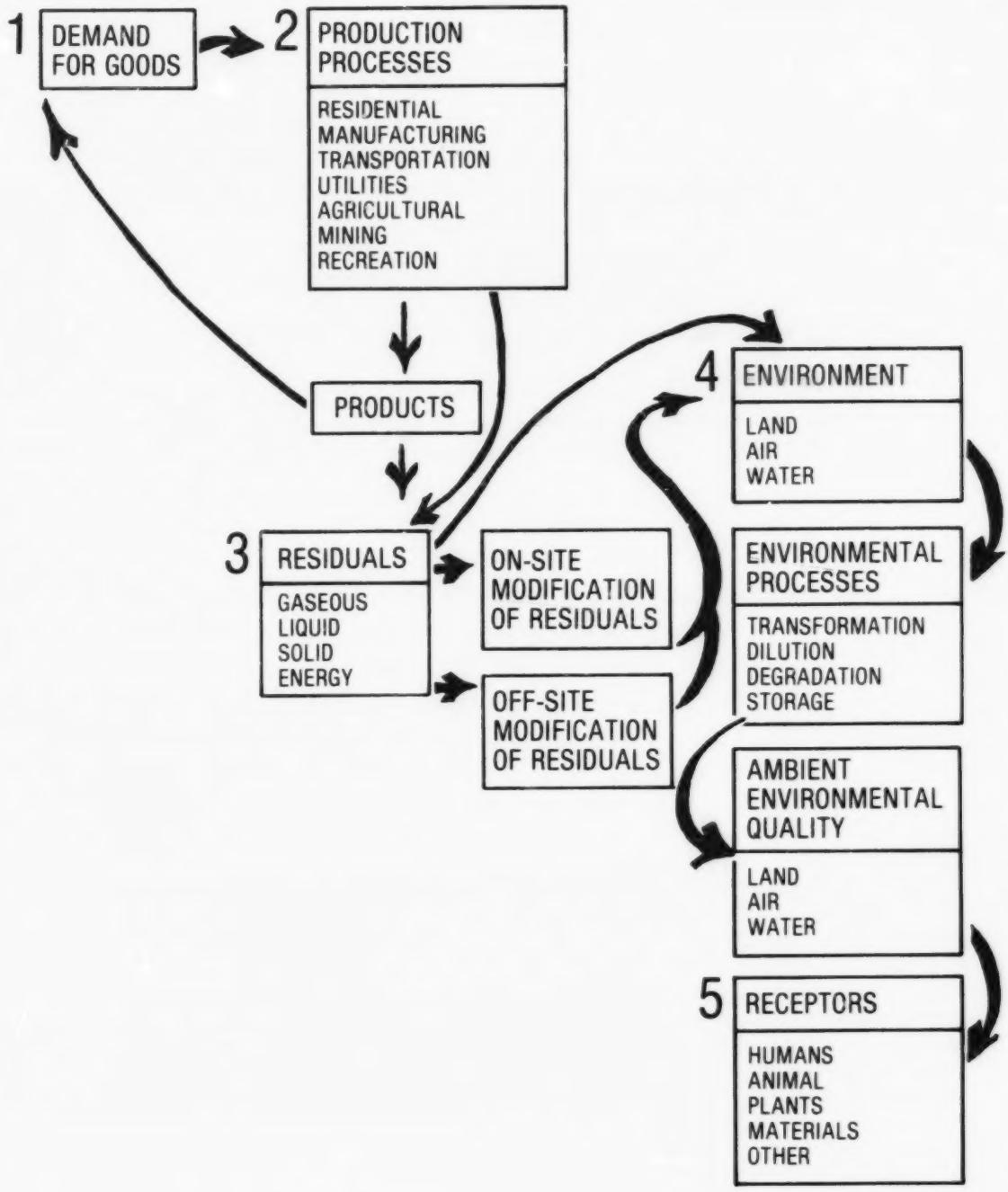
WHAT IS THE RESIDUALS GENERATION AND DISCHARGE MODEL?

In response to producer and consumer demands for goods and services, the production process brings together raw materials, labor, and energy to produce a product or service. The production process also results in non-product outputs (outputs which are not the primary or intended product). Non-product outputs may be utilized or discarded, depending on their economic value. If utilized, they are intermediate products; if discarded, they are residuals. In other words, residuals are non-product outputs which would not be recycled, reused or recovered unless some type of environmental or pollution control were imposed on the producer.

Residuals can be handled by different methods:

1. Modified or treated on-site;
2. Collected, and modified or treated, off-site;
3. Discharged into the environment without modification or treatment.

THE RESIDUALS GENERATION AND DISCHARGE MODEL



2. IDENTIFYING THE RESIDUALS MANAGEMENT STRATEGY

■ WHAT IS A STRATEGY?

A residuals management strategy combines three components—physical methods, implementation measures, and institutional arrangements—to reduce or eliminate the discharge of residuals into the environment, and/or to lessen their impact on environmental quality if they are discharged.

■ HOW TO FORMULATE ALTERNATIVE STRATEGIES

After determining goals and objectives, and identifying problem sources, alternative residuals management strategies can be formulated in three steps:

First: Identify physical methods which can be introduced at each point along the residuals generation and discharge model.

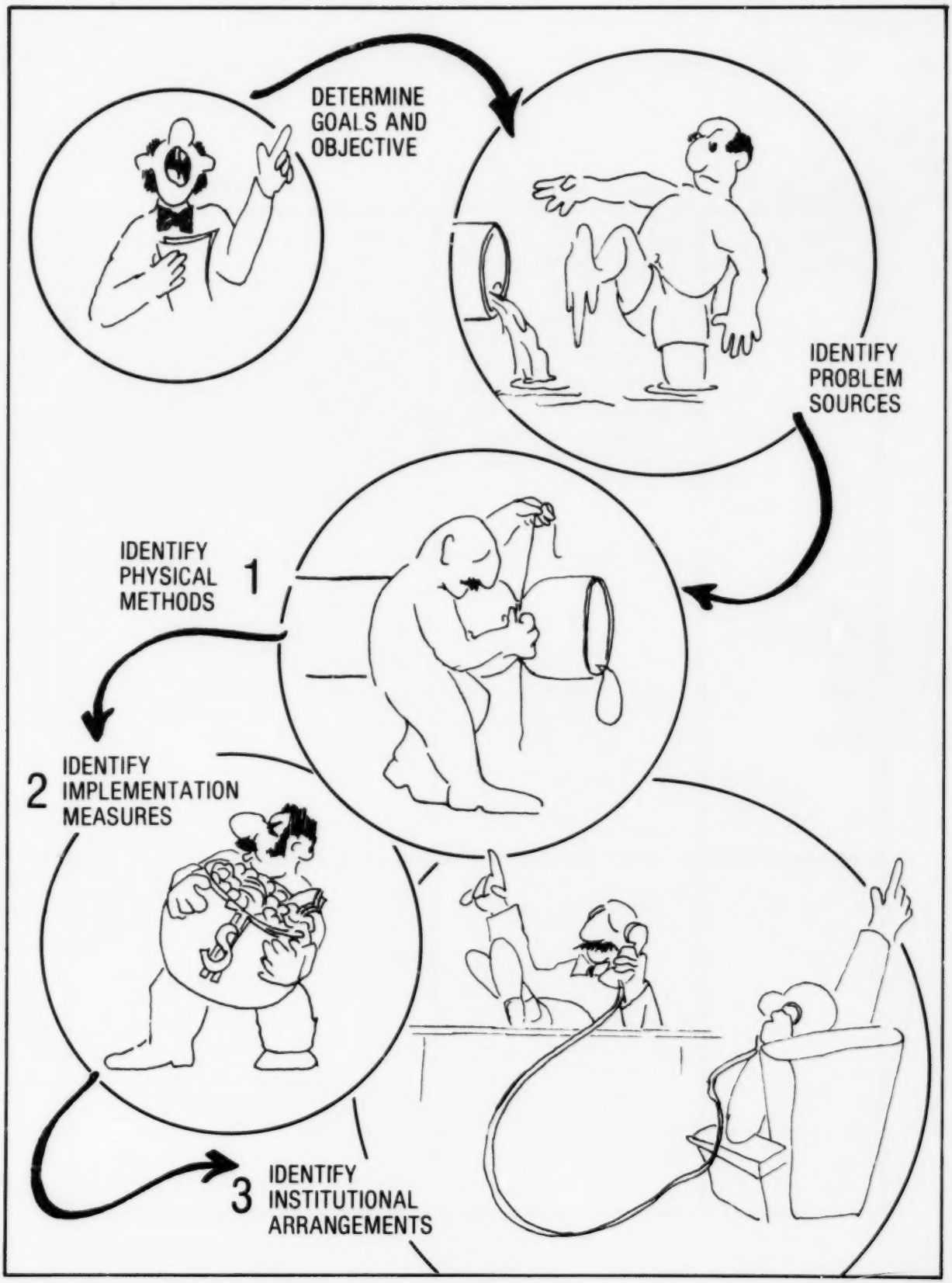
Second: Identify implementation measures which will induce implementation of the identified physical methods.

Third: Identify the institutional arrangements which have the capacity to adopt, implement and enforce the implementation measures.

NOTE:

Since the residuals generation and discharge process take place in a certain area, external factors particular to that area may well determine whether a leftover has some economic value or none, thus determining the degree of its usefulness to the producer as an intermediate product or its uselessness as a residual.

External factors such as prices and supplies influence the production/consumption process and therefore the residuals generation and discharge process. Other factors such as import taxes, unemployment compensation, or minimum wages may affect materials, capital, or labor. The administrator should consider these factors, which may heavily influence the generation and discharge process, when planning strategies for residuals management.


DETERMINE GOALS AND OBJECTIVE
IDENTIFY PROBLEM SOURCES
IDENTIFY PHYSICAL METHODS 1
2 IDENTIFY IMPLEMENTATION MEASURES
3 IDENTIFY INSTITUTIONAL ARRANGEMENTS

RESIDUALS MANAGEMENT STRATEGIES ARE COMPRISED OF THREE COMPONENTS

	COMPONENTS	DEFINITIONS	EXAMPLES
1	PHYSICAL METHODS	■ Specific physical action, technologically based, that result in ■ changing the quantity, type, timing, or spatial location of discharged residuals; or ■ improving the assimilative capacity of the environment.	■ Changing production process technologies ■ Changing the operating rate of the production process ■ Treating residuals ■ Changing the environment to increase its assimilative capacity
2	IMPLEMENTATION MEASURES	■ Measures such as regulations, laws, or ordinances that induce residuals generators to use appropriate physical methods for controlling residuals.	■ Limiting residuals emissions ■ Passing zoning regulations ■ Authorizing federal funding for treatment plants ■ Depreciating pollution control devices at an accelerated rate.
3	INSTITUTIONAL ARRANGEMENTS	■ Governmental and administrative agencies that can ■ select, initiate, operate, and enforce physical methods, and ■ identify and adopt implementation measures.	■ Federal, state, local, regional, and interstate legislative and administrative bodies. ■ Inter-agency and intra-agency planning and cooperation.

ADMINISTRATORS CAN CONSIDER A NUMBER OF METHODS FOR EACH ALTERNATIVE:

	Alternatives	Methods
1	REDUCTION IN GENERATION OF RESIDUALS CAN BE ACCOMPLISHED BY:	■ Changing final demand for the mix and/or characteristics of goods and services—e.g., switching from disposable to returnable containers. ■ Changing production processes—e.g. if sulfur fumes from an open-hearth furnace create air pollution, a different method of manufacturing steel, such as the basic oxygen furnace, may be introduced. ■ Changing raw material inputs—e.g., changing from high sulfur content coal to low sulfur content coal would help reduce the residual SO_2.
2	MODIFICATION OF RESIDUALS AFTER GENERATION CAN BE ACCOMPLISHED BY:	■ Residuals modification and/or recovery on-site. ■ Residuals modification and/or recovery off-site in a collective facility. ■ Residuals modification to a less harmful form of residual in order to eliminate or reduce its adverse effect on the environment.
3	IF RESIDUALS ARE DISCHARGED INTO THE ENVIRONMENT, THE ASSIMILATIVE CAPACITY OF THE ENVIRONMENT CAN BE IMPROVED BY:	■ Changing the spatial distribution of production activities ■ Changing the timing of production activities ■ Changing the spatial distribution of the discharge of residuals.

NOTE:

There are many points in the residuals generation and discharge model that can be identified and used as "valves" to control the process; before turning those valves, however, administrators should define specific environmental problems and their sources, establishing a relationship between those problems and possible strategies for eliminating or reducing them.

MODIFICATIONS IN THE RESIDUAL GENERATION AND DISCHARGE MODEL

PROCESS	1 DEMAND	2 PRODUCTION	3 RESIDUALS	4 ENVIRONMENT	5 RECEPTORS
MODIFICATION	MODIFICATION OF DEMAND	MODIFICATION OF PRODUCTION	PROCESSING OF RESIDUALS	MODIFICATION OF ASSIMILATIVE CAPACITY	FINAL PROTECTIVE MEASURES
METHODS	1. REDUCE OR ELIMINATE DEMAND 2. CHANGE TIME AND/OR PLACE OF DEMAND	1. CHANGE LOCATION OF ACTIVITIES 2. CHANGE TIME OF ACTIVITIES 3. CHANGE RAW MATERIAL INPUT 4. CHANGE ENERGY INPUT 5. CHANGE MIX OF PRODUCT OUTPUTS 6. CHANGE PRODUCT SPECIFICATIONS 7. CHANGE PRODUCTION PROCESS	1. ON-SITE MODIFICATION AND/OR RECOVERY 2. OFF-SITE MODIFICATION AND/OR RECOVERY	1. MAKE BETTER USE OF 2. INCREASE CAPACITY OF	1. INDIVIDUAL 2. COLLECTIVE

3. CLASSIFYING AND IDENTIFYING STRATEGIES

- THREE WAYS OF CLASSIFYING COMPONENTS OF THE STRATEGY:

1. Classify physical methods according to their points of introduction in the residuals generation and discharge model. Relate these methods to the source activities that cause the pollution problem.
2. Classify implementation measures according to their effect or purpose—regulatory, economic, administrative, informative. Relate physical methods to implementation instruments necessary to ensure their use.
3. Classify institutional arrangements according to different levels and types of government. Relate implementation measures to institutional arrangements which can enact such measures.

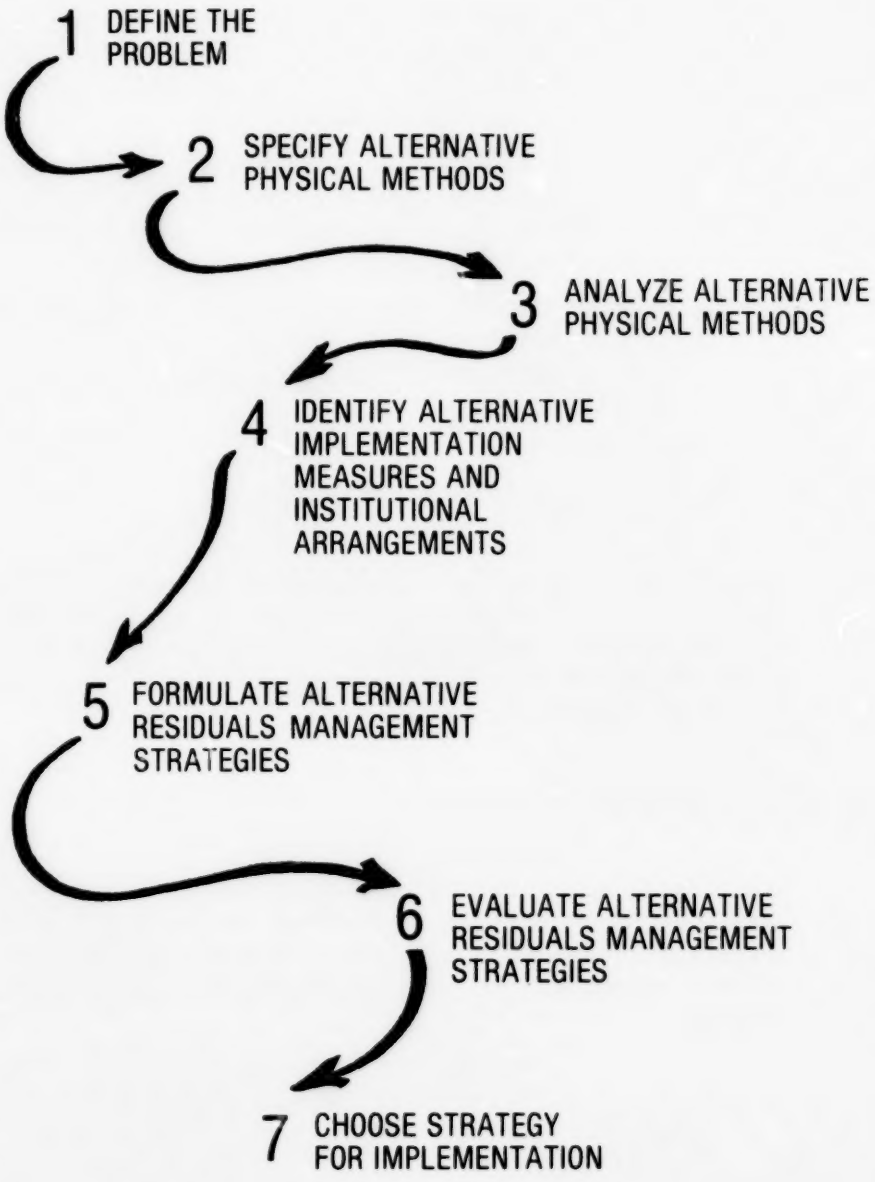
4. RELATE COMPONENTS TO THE MODEL

Starting at each point of introduction along the residuals generation and discharge model—e.g., final demand, production process—identify applicable physical methods, implementation measures and institutional arrangements that will accomplish the desired environmental objectives.

5. ENFORCING THE STRATEGY

After choosing appropriate strategies, administrators must, of course, apply and enforce them. The study does not deal in depth with implementing and enforcing residuals management strategies, but rather concentrates on steps for developing and evaluating strategy alternatives.

6. DEVELOPING AND EVALUATING A RESIDUALS MANAGEMENT STRATEGY INCLUDES THE FOLLOWING SEVEN STEPS:


1 DEFINE THE PROBLEM
2 SPECIFY ALTERNATIVE PHYSICAL METHODS
3 ANALYZE ALTERNATIVE PHYSICAL METHODS
4 IDENTIFY ALTERNATIVE IMPLEMENTATION MEASURES AND INSTITUTIONAL ARRANGEMENTS
5 FORMULATE ALTERNATIVE RESIDUALS MANAGEMENT STRATEGIES
6 EVALUATE ALTERNATIVE RESIDUALS MANAGEMENT STRATEGIES
7 CHOOSE STRATEGY FOR IMPLEMENTATION

1

STEP 1

DEFINE THE PROBLEM

1. Define the problem in terms of
   - Residual characteristics: gaseous, liquid, solid, energy
   - Sources: residential, manufacturing, transportation, utilities, agriculture, mining, and recreation.
   - Media: air, water, land.
2. Classify residuals in terms of their intermedia effects—the way they interact with two or more media.

2

STEP 2

SPECIFY ALTERNATIVE PHYSICAL METHODS

1. Specify physical methods in relation to sources of the problem.
2. Differentiate among sources in terms of possible points of introduction in the residuals generation and discharge process.

NOTE:

These two steps provide a "baseline" inventory and analysis of problems.

3 STEP 3

ANALYZE ALTERNATIVE PHYSICAL METHODS

1. Analyze methods in terms of
   - Physical effects
   - Economic effects.
2. Utilize models if resources are adequate; if resources are limited, call upon a panel of advisors or experts.

4 STEP 4

IDENTIFY ALTERNATIVE IMPLEMENTATION MEASURES AND INSTITUTIONAL ARRANGEMENTS.

1. Consider actions prescribed by regulations or ordinances, or actions offering incentives for changes in the production processes used by residuals generators.
2. Consider agencies at various levels that can oversee and enforce implementation measures chosen..

5 STEP 5

FORMULATE ALTERNATIVE RESIDUALS MANAGEMENT STRATEGIES

1. Consider the results that can be expected from each strategy in terms of
   - the environment
   - the economy
2. Utilize information developed in Step 3 for each residuals management strategy. This information would indicate the reductions to be achieved for each residual as well as costs for each strategy.

6

STEP 6

EVALUATE ALTERNATIVE RESIDUALS MANAGEMENT STRATEGIES. SUGGESTED CRITERIA:

1. Physical effects:
   - Reduction of residuals (quantity)
   - Improvement in environmental quality
2. Economic effects:
   - Direct costs: expenditures required to respond to a particular strategy. These costs include investment and operating costs for control equipment, incremental costs of fuel switching, costs of production process changes, emission monitoring costs, administrative costs for accounting and reporting, costs of supervising personnel, and costs required for implementing and enforcing a strategy.
   - Other economic effects to society: employment, income to other firms, change in income tax and property taxes, increased cost of user goods, and dislocation of people.
3. Legal considerations:
   - Enabling legislation
   - Legal precedents
   - Susceptibility of implementation measure to legal challenge
   - New legislation required
4. Administrative considerations: flexibility of the strategy in terms of
   - Seasonal variations
   - Changes in prices, technology over time
   - Ability of the strategy to incorporate new information
   - Effects of new goals and priorities

5. Time considerations:

   - Time required to implement strategy
   - Time needed to obtain first results and/or benefits

6. Political considerations:

   - Feasibility of adoption

7. Public Responsiveness:

   - Public response survey

7

STEP 7

CHOOSE STRATEGY FOR IMPLEMENTATION

1. Use the materials generated in the evaluation process in Step 6 to choose the most practical strategy.
2. Obtain advice from other sources as necessary.

NOTE:

If those who participate in the development of the residuals management strategy are also those responsible for its implementation and enforcement, they will have a better understanding of the obligations they are assuming. They will also have a more realistic view of the results they can expect in terms of reduced residuals discharge into the environment, the economic and social effects of that reduction, and the outlook for improvement in environmental quality.

3 Applications

- WHAT TO LOOK FOR
- WHERE TO LOOK

3. THE APPLICATIONS

WHAT TO LOOK FOR

The study contains an extensive bibliography of practical publications covering many aspects of environmental pollution control. These publications range from Alternatives to the Internal Combustion Engine through The Zoning Dilemma. A number of theoretical references are noted at the end of each chapter in the study.

WHERE TO GET THEM

Information on availability of copies of "Development of Residuals Management Strategies" can be obtained from:

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4 Conclusions

- CONCLUSIONS
- RECOMMENDATIONS
- PROJECT IDENTIFICATION

4. CONCLUSIONS & RECOMMENDATIONS

CONCLUSIONS

1. Human activity results in residuals that are generated and discharged into the environment, affecting its quality. To the extent that human activity can be changed, environmental quality can be enhanced.
2. A planning process to identify, evaluate, and select strategies for overcoming or alleviating environmental problems caused by residuals discharge can be based on the framework of a residuals generation and discharge model.
3. This model identifies different methods for complying with recent federal legislation that requires a specified level of environmental quality.
4. This model provides a method for identifying and evaluating residuals management strategies. These strategies are helpful in the formulation of environmental assessments and impact statements.
5. The residuals management strategy identifies many points in the residuals generation and discharge model at which physical methods can be introduced, or changes made, to reduce or alleviate the effect of discharging residuals into the environment.
6. A planning process that uses the residuals management model can prove beneficial to elected officials and administrators at all levels of government. It is particularly useful to local and regional officials who must deal with problems first-hand.

RECOMMENDATIONS

1. A planning process for residuals management (pollution control) could use the residuals generation and discharge model as a framework.
2. The planning process for identifying residuals management strategies should start without considering legal, political, technological, or social constraints so that officials can examine the broadest possible range of alternatives.
3. Decision makers should consider all reasonable alternatives; they should not limit themselves to conventional, end-of-the-pipe solutions to residuals problems.
4. A planning process that uses the residuals generation and discharge model should be followed by consumers, labor, business, and government—by all decision makers concerned about environmental quality—so that they share a common base for their residuals management decisions.

PROJECT IDENTIFICATION

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